

## The Design of Administrative Building Based on Climate Considerations: A Case Study in Khuzestan Engineering Systems Buildings

Jalil Ghazaei Manghutay

Department of Architecture, Kish International branch, Islamic Azad University, Kish, Iran

### Abstract

This study was conducted with looking ahead to optimize the use of energy in Iran as a developing country with many challenges in building industry at the present time and regarding a better future and respecting the criteria of old architecture as well as following contemporary architecture and outbreak of technology for the users' more comfort. Popularity of construction based on the design in harmony with the climate, can lead to significant effects on reducing energy consumption if its condition and context are provided in the body of the city. By reviewing the elements and rules of architecture and urbanism in Iran indicated as codified rules in article 19 of Building National Regulations and in other parts of the world as some movements with sustainable architecture a system in line with this direction can be developed. Hence, the way buildings are constructed next to each other in a neighborhood, and the way to create the body of cities with the emphasis on the issue of wasting energy in the buildings were studied by looking at the contemporary urbanism of Iran. Therefore, the issue of coordination of height of neighborhoods buildings and adjacent buildings, the width of passages and height of buildings, the use of different materials in the walls of the building with appropriate thermal capacity and considering the climate architecture of each region as the lasting archetypal and combining it with modern technology can be effective in developing the rules of urbanism of each region. It is hoped that reviewing urban plans and laws of the city and removing deficiencies can create appropriate urban body and perfect context to popularize the construction of buildings compatible with the climate to reduce the waste of energy in the building and lead to more comfort for citizens.

**Keywords:** design in harmony with the climate, waste of energy, article 19 of Building National Regulations, sustainable architecture

### Introduction

Natural environment as a context for human activities has a systematic structure. This system has the features of both quantitative and qualitative elements that form the structure of the environment. Each of these components also plays certain role that these roles altogether create environmental practices. In fact, the formation of different types of human settlements and activities in different places are a response to the actions of the elements in nature. Overall, by this approach that identifying the environmental identity as the basis of human activities can result in better understanding and analyzing the various forms of life and human activities and important ecological environmental factors have been studied and analyzed that the most important ones are:

- Topography;
- The network of rivers and surface flows;
- Climate features (including rainfall, temperature, humidity, wind, etc.);
- Groundwater and surface water resources;
- Geological structure;
- Vegetation cover and animal life;
- Natural attractions and resources.

Because of the reduction of fossil fuels resources and the destruction of the global environment, which is often caused by the use of fossil fuels, increase in the prices of fossil fuels also increases the importance of reducing energy consumption. Since about 40 percent of the world's energy is consumed by the construction sector, introduction and implementation of efficient energy buildings could reduce global energy consumption. Designing low-energy buildings is one of the most important ways to reduce energy consumption in buildings. Since all three aspects of the building architecture, thermal shell strength of the building and the efficiency of building facilities systems are effective on the energy consumption of buildings, each of these three aspects can be used to reduce energy consumption of buildings. An aspect of the building which should be first regarded to reduce energy consumption of buildings is architectural aspects. In order to achieve the design of efficient energy architecture; the building architecture should be designed based on the climatic conditions and the potentials and restrictions of the environment should be taken into consideration. Therefore, the first step in designing efficient energy is accurate knowledge of climatic condition and determining the potentials and facilities in building sites in order to achieve an architecture based on accountability to climate and as a result an architecture of efficient energy. Following article 19 in designing and constructing of the building is mandatory. But the features regarded in the Building National Regulations, since it has an approach of developing standard, the dimensions of the skylights, the building and material and wall thickness are more considered; however, it is silent in the field of guiding criteria of designing which help set environmental conditions inactively. This study aimed to find design criteria to apply them in today's administrative buildings in the warm and semi-humid climate.

### **Methodology**

The method was based on the objectives, the type of data and how to implement:

At this point, the experimental research strategy was used to achieve the result which was to find the design criteria appropriate to the climate. In this study climate data, result in developing appropriate criteria to design administrative buildings in harmony with the warm and semi-humid climate of Ahvaz, Khuzestan, Iran. Then, based on experimental strategy, the designed sample for the building of engineering systems was measured with design criteria and standards of article 19 to see if the criteria developed are efficient and reliable in the field of administrative buildings in the warm and semi-humid climate or not.

### **The effects of climate on architecture**

The relationship between architecture and climate is like the relationship between a baby and mom's hug or any plants and soil. In this meaning, hug, soil and climate connect life and happiness and lack of them present death. The experiences of native architecture throughout the world and its Arvin in Iranian architecture, is the proof to emphasize the idea of regarding climate considerations in architecture rather than its constraints or the architect captivity. Different rates and different combination of climatic factors caused by the difference of geographically different areas created a different climate zones, each with its own characteristics. Environment, towns and even monuments related to the fields of climate obtained certain characteristics according to their own conditions.

### **Climate divisions in Iran**

Basically, in many parts of the world, the climate is determined by latitude and altitude. Iran, being between 25 and 40 degrees of northern latitude is located in hot area and in terms of altitude is a high plateau that the total of its levels with the height above sea level of less than 475 meters, make up a very small percentage of the whole country. Despite the fact that now Iran has two large water area (the Caspian Sea and the Persian Gulf), because of the Alborz and Zagros Mountains and

their placement, the effects of these two areas is limited to areas very close to them and these areas are rarely effective in moderating the temperature of internal parts. Certainly, in the mountainous country like Iran two places are never alike in terms of climate. However, the best way to achieve a basis to determine the climatic zones of the country is coupon principles which should be followed. Therefore, Iran's four divisions suggested by Dr. Hassan Kenji cannot be used. He accepted the coupon division with a few changes with regard to the geographical features of the country as follow:

- Moderate and humid climate (southern Caspian coastal);
- Cold climate (Western Mountains);
- Warm and dry climate (Central Plateau);
- Hot and humid climate (Southern Coast);

### **The nature of climatic design**

The urban body and architecture harmony with the climate, a review on written literature in the field of optimized fuel consumption in the building show that it has been for a long time that engineers and researchers have been interested in correcting the methods of designing buildings (one building). Although it is valuable but should not be forgotten that along with every detailed view the general view should also be considered. In other words, it should be noted that, in addition to the fact that all buildings (alone) should be designed and implemented with less waste of energy (or without waste of energy). It should be remembered that it is necessary the placement of the buildings next to each other should be done in this regard. In fact, urbanism and related criteria should also be available to serve this objective (or without any bad effects). In other words, popularizing construction based on the basis of design harmony with climate can be effective when have significant effects on reducing waste of energy when its context is provided in cities. Because on one hand a good number of people accommodated in big and mega cities or working there and on the other hand the most percentage of construction is being carried out in cities and consequently the majority of waste of energy in buildings is also associated with settlement and accommodation in city and urbanism.

### **Khuzestan locations**

Khuzestan province, with an area of over 67282 square kilometers is located between 47 degrees and 41 minutes to 50 degrees 29 minutes east of the Greenwich meridian and 29 degrees 58 minutes north latitude and 32 degrees 40 minutes from the equator. It is limited to Ilam, Lorestan, and Isfahan from North; Chaharmahal-Bakhtiari and Kohgiluyeh-Boyer Ahmad from the East, Bushehr province and the Persian Gulf from South and to Iraq from West. Ahvaz is the capital of Khuzestan province and consist of the following cities:

Abadan, Andymeshk, Baghmalk, Ize, Bandar Mahshahr, Behbahan, Khorramshahr, Shushtar, Dezful, Dasht Azadegan, Rāmhormoz, Shadegan, Shush, Masjed Soleiman. (Iran Statistical Center, 2006).

### **Features of local architecture**

After the characteristics, the tissue of traditional housing in Ahvaz was studied. Traditional architecture of the city is not as old as Dezful and Shush. In this climate, the natural ventilation during the day should be minimized because by arrival of outside warm weather into the building the temperature of internal surfaces increases. Especially during the day when the wind speed is high indoor air temperature variations in the vicinity of the outside air temperature changes. In the evening and at night because of lower external air temperature and being close to indoor air temperature natural ventilation can be created through windows; however, it should be noted that the

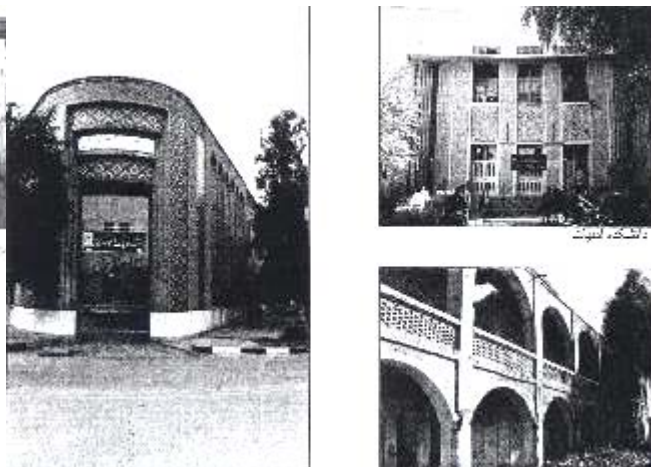
window size should be proportional to their efficiency and their size and shape and where and how to be open should be chosen so small that the heat absorbed through windows gets minimized and should also consider the issue of dust into the building (Kasmaee, 2003).

### **The constituent elements of traditional buildings architecture**

The system of architectural structure in Ahvaz in all cases of the system, traditional load-bearing in Ahvaz consists of the walls made of heavy materials located in the two sides of the space and the weight of ceiling was one direction to the walls. The thickness of the traditional walls was 60 cm and then decreased to 45 cm. At first the walls were made of stone but then of clay or bricks. The ceiling was made of timber, the pipes were covered with straws and the outer surface was lined with thatch. In many cases, a lower roof was torn up to hide straw and timber in the ceiling. The cover of the roof created in this way was considered as a good thermal insulation. In some cases, the coverage system was domed brick ceilings which were placed on the stone walls. In traditional architecture of Ahvaz, load-bearing walls constituted two sides of the space and the other sides were the filling sections. The system of load-bearing walls was identified in the yard. The materials of filling sections were mostly made of clay or brick. In order to hide the moisture rising from the internal walls, the wooden superficies were used. Although the height of filling ceiling was high, sometimes in upper parts some pores were created covered by mosaics brick. However, this material is low in Ahvaz (figures 1 and 2).



**Figure 1: The buildings of Khuzestan Province (Source: author)**



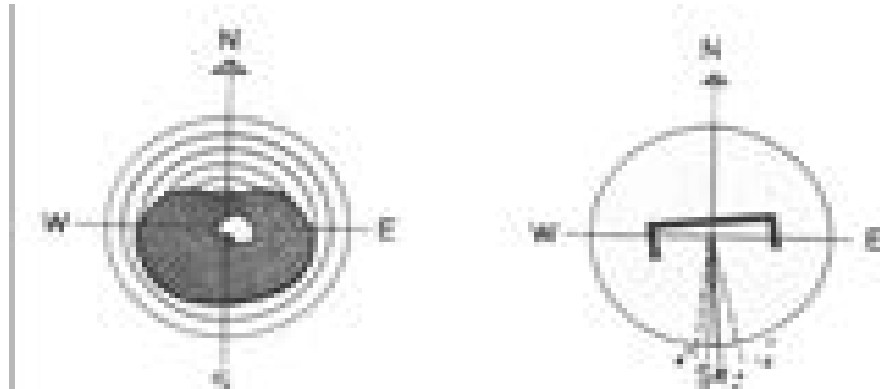
**Figure 2: The buildings of Khuzestan Province (Source: author)**

### **Responding the climatic needs**

#### ***Building orientation***

Building orientation in the area and its angle towards the north are determined by various factors. Slope curvature of the earth, especially in buildings with large scale, the situation of the area and the location of entrances and access routes, landscapes around the site and the climatic conditions of the region are among the factors that can be mentioned. To have the most logical orientation of the building it is needed to study each of the factors mentioned and with regard to economic issues, executive and determine the best combination of functionality and aesthetics. Therefore, in this part the ideal side of the building is determined in terms of the movement of the sun and the weather conditions of the region. Obviously, the final orientation of the building will be determined after reviewing and comparing all these factors. Due to the fact that the orientation of the building does not affect the amount of energy absorbed from the ceiling of the building, from the

diagram of the intensity of sunlight it can be concluded that the most appropriate building orientation in terms of sunshine is North-South direction With a deviation 15 degrees from South to East. In other words, if the long axis of the building was in the East and West direction, the walls of buildings absorb the most sunlight.



**Figure 3: The orientation of the building in warm and humid climate**  
(Sources: Kasmaee M. Climate and Architecture)

### **Studying the methods and techniques of climatic design appropriate to the climatic areas**

Climatic design is a way to reduce the cost of energy in a building. Building design is the first defensive line against external climatic factors. In all weather conditions, the buildings constructed based on the principles of climatic design reduce the necessity of mechanically heating and cooling and in exchange uses natural energy around the building. Money saved in the long time changes the implementation of climatic design techniques as the best investment for the owners of buildings. Many of them do not need money and only requires knowledge about climatic design. Other methods are easily applicable in ordinary buildings. Climatic design tools include windows, natural lighting, greenhouses, loggia and courtyard. This set provides an environment that creates a balance between our world and surrounding environment.

#### **Traditional methods and techniques**

The amount of rainfall in this area is very low and the intensity of sunlight and evaporation is really high which leads to water salinity. Water shortage and soil salinity led to poor vegetation cover leading to the flow of moving sands and high velocity of warm and dry winds. In this situation, providing people's comfort depends on the skills so that they could create buildings and spaces in line with echo logic environment and climatic conditions. In this area, the climatic comfort was provided in three ways: using shadow and wind, using water, managing water and reducing the effect of sunlight. Accordingly, the principles governing urbanism in warm and humid climate of Iran in order to achieve comfort can be studied as follow:

- First principle: orientation;
- The second principle: the dense tissue;
- The third principle: indoor organic passages;
- The fourth principle: The use of materials with high thermal capacity;
- The fifth principle: introversion and central courtyard;
- The sixth principle: artistic use of water and plant.



### **Modern methods and techniques**

Today, development and industrial growth, in addition to many amenities has brought about many environmental problems on a national, regional and global level. The growing trend of air pollution, the gradual warming of the atmosphere, greenhouse gas emissions and their impact on the ozone layer have created serious challenges in terms of climate. These problems sometimes are not caused by technologies but for lack of attention to side effects, incorrect application of technology and lack of attention to the governing rules and regulations. However, efforts to reduce the harmful effects in sustainable development along with using modern technologies, respecting the governing rules and the need to review set of rules adopted by developed countries In relation to sustainable development and matching them with the physical condition seem essential. As urban development destroys their natural environments, in this regard, the new movements and styles in architecture have been arisen each with guidelines, principles and developing some special rules try to solve the climate and integrate the building with its bed as natural things and nature-loving not destructive factor that deals with the principle of sustainability and authenticity of energy and can be identified through the branches and separation of elements.

### **Sustainable Architecture**

The faces of cities around the world each with a different world in themselves are rapidly fading what giving them identity which has provided similarity and integration. Architecture and city for pre-modern man was an innovative product which was the result of climatic constraints and structures on one hand and collective beliefs of the party and the people from the other hand. What has built its artificial space was resulted in the context and along and in line with the characteristics of the region. This link has caused the architect's brain result moved in the area of features and musts from local materials and environmental conditions. Sustainable development is a development to meet current needs in such a manner that does not reduce the ability of future generations to meet needs. With regard to the points mentioned, it was tried to explain the concept of sustainable development and design and by introducing some strategies creates the possibility of fulfilling this belief. Architects along with other experts are trying to find new solutions to provide ideal life for man. Obviously, living, working, leisure, resting and etc. all are the activities done in the spaces designed by architects and since the weak and strength points of a building directly affect the world environment, architects are critically responsible in this regard. The most important topics of sustainable architecture are the following titles:

- Echo Tec architecture;
- Green architecture;
- Sustainable architecture;

### **The objectives of sustainable architecture**

Giving importance to human life and its preservation at present and future, application of materials which are sustainable and homogenous with their environment during production and application or even destruction, minimum use of fuel energy and maximum use of natural energies, minimum use of fuel energy and maximum use of natural energies, minimum damage to the environment, improving the physical and psychological human life and all living things, harmony with the natural environment. The buildings are designed to reduce the damage on the environment, energy and natural resources, including the following rules:

- Reducing the consumption of non-renewable resources;
- Developing the natural environment;
- Removing or reducing the consumption of materials toxic or harmful to nature in the building industry.

Achieving high standards of quality, safety and welfare that actually provides the human health is the most important goals of sustainable architecture that achieving such conditions takes place using the efficient management and use of the latest technologies.

### **Principles of sustainable architecture**

Sustainable architecture like other architectural issues has its own specific rules, and it involves three steps:

- Saving resources;
- Designing to return to the cycle of life;
- Designing for man with specific strategies;
- Identifying and studying the decisions leads the architects to understand the environment that they should design it;

### **Reviewing article 19 of Building National Regulations**

Building National Regulations of Iran, as the comprehensive criteria in the field of construction, undoubtedly play an important role in achieving the goals of higher safety, health and economy saving of the individual and society and following them in addition to fulfilling the objectives lead to developing the quality and adding the useful life of the buildings. Based on this importance, developing and explaining Building National Regulations is considered as a turning point in the history of the country's Civil Engineering initiated by the Ministry of Housing and Urban Development and with the participation of national engineering society and in the context of developing the Council of Building National Regulations and specialized committees were organized and developed uninterruptedly. In this way, in addition to the completion and review of pre-defined topics and their compliance with the requirements of the country in terms of economic, technical, cultural, social, development of new topics were on the agenda which will be introduced to engineering community after final editing and approval process. At the present time several technical documents such as Building National Regulations, codes, standards and technical specifications are published in the country and users are needed consider their differences based on the purpose of providing any documents, obligation, territory, context and other especial features of any documents that in the case of Building National Regulations the following features can be included:

Building National Regulations are needed to be implemented throughout the country. Provisions of the Building National Regulations are briefly summarized and formulated. According to the necessity of implementation of National Building Regulations, the Regulations do not involve any recommendation and guide. National Building Regulations govern any building activities such as demolition, construction, land use change, development, construction, major repairs and the like.

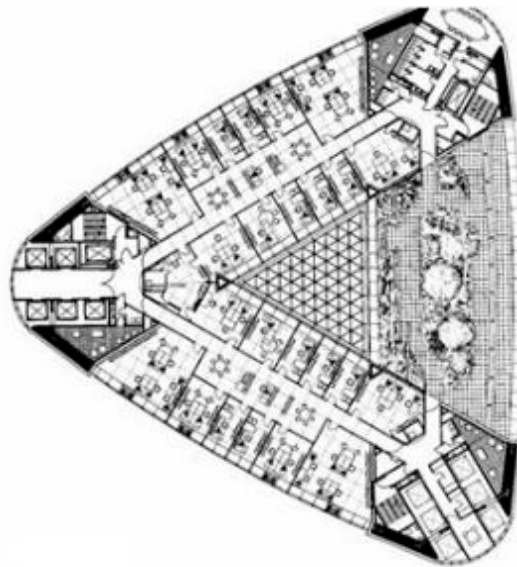
### **Studying international cases**

#### ***Supervision branch of Commerz Bank, Frankfurt***

The new Commerzbank headquarters in Frankfurt was the first high-rise tower with 60 floors and environmental considerations as well.

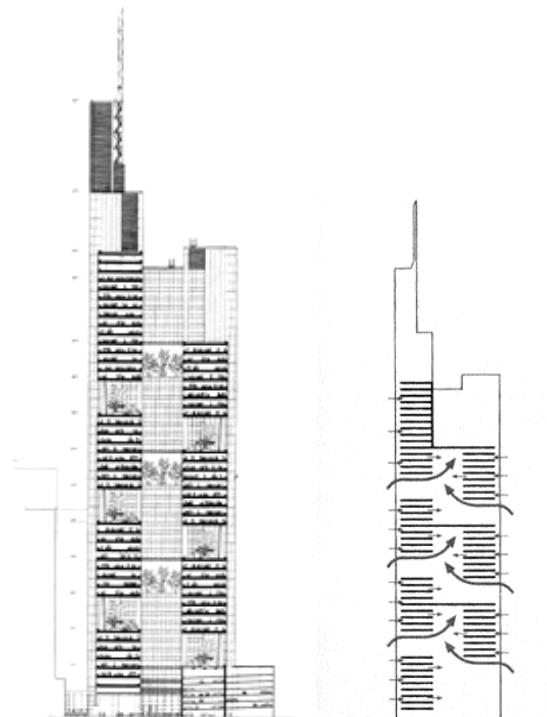
This design regarded the principles of a huge administrative building in combination of ecological ideas and also the patterns of an administrative environment, so that natural ventilation and opening windows are used. Its Gardens on all four floors appear as social interaction and visual concentrations. This garden is used by the staff in leisure hours as a place to relax which enhances the natural and human dimensions of working spaces and from the outside, gives the building a sense of transparency and lightness. The type of plants to be planted in the garden is different

according to their different directions, and includes plants from North America, Asia and the Mediterranean.



**Figure 4: Supervision branch of Commerz Bank, Frankfurt**  
(Source: Aldo Benedetti, 2005)

The gardens are adjacent to a central atrium that goes up the full height of the tower and works as a natural chimney for internal office tower. The building plan is like a triangle, each side to increase efficiency was softly curved. Elevators and public bathrooms were deployed in the corners.



**Figure 5: Ventilation in winter and summer**  
(Source: Aldo Benedetti, 2005)



### **Studying national cases**

#### ***Mashhad Engineering systems***

Mashhad engineering systems is a public organization founded in 1918 and was assigned to handle Mashhad affairs. Mashhad Mayor, previously were appointed by the interior Minister of Iran but now he is chosen by the city council in Mashhad, manages the organization. Mashhad engineering systems include 13 regions that deputy of mayor of the region is responsible to manage it. The construction of the current building of Mashhad engineering systems designed by German engineer in four floors dated back to 1941 but its implementation because of some problems by replacing a few years began with the gradual construction of basement and ground and first floor. In 1953, the office of Mashhad engineering systems moved to the current building and the western side of the building in exchange of building the second and third floors were assigned to Agriculture Department for five years by Ex- mayor Abdul Wahab Eghbal. After 20 years, around 1973 second and third floors of eastern side of the building were constructed by "Malone" Construction Company under the supervision of engineer Alasti. The building was 4646 square meters in 1969 that engineering systems developed it by buying the adjacent buildings. Now the field of engineering systems building is 5915 /70 sq.m. And the lord of each floor is 1877 /90 sq.m. And the position of the building is three sides and with steel structure and stone facade.

#### **Architectural features of administrative building of Mashhad engineering systems development**

In designing the architecture of administrative building of Mashhad engineering systems development, according to the purpose of establishing all general management of Mashhad engineering systems and due to lack of space in the existing building of engineering systems, the building of engineering systems development was designed and implemented in order to develop and the overflow of administrative activities of Mashhad engineering with regard to the following characteristics:

Open administrative system to create spatial flexibility and change the layout of spaces; clients' easy access to facilitate people's requests to the building. Also new building should be combined with traditional building and represent the physical collection of unit for Mashhad engineering system. And to this end, the building with a free-form in plan introduces new architectural achievements of the country. Moreover, since the city of Mashhad is located in an area where the need for heat energy is high, the architecture of the building has been designed to meet these needs.

#### **The suggestion of energy savings ideas based on the architecture of Mashhad**

The building was made in line with the geographic north-south direction in order to obtain more energy from the sun in cold seasons and from and gets the most amount of sunlight from the outer walls of the south side between 9 AM to 3 PM. Since the prevailing wind in Mashhad is West-East, the length of the sides of the building is reduced in the eastern and western direction and the building is less exposed to the effects of bad winds. In order to further reduction of sun radiation, the walls of the light passages into the building were used and also taking into account the angle of solar radiation in the hottest time, aluminum canopy was used on the south side and in western and eastern sides by denting in the walls of light passages prevented the sunlight getting into the building which caused the reduction in cooling in summer. The materials with high thermal inertia have not been used in the interior and exterior walls which are appropriate to the temporary use of the building. External walls of the building have also been insulated to create less thermal inertia for the building and in total; the building was implemented light in terms of surface weight. The

openings in the building are against each other in order to use them in the hottest time of the year to open them to use the natural flow of air and cool the building.



**Figure 6: Mashhad engineering systems**  
(Source: author)

### Conclusion

Since architectural design has effects on energy consumption for heating, cooling and lighting of buildings and thus the primary energy consumption and carbon dioxide emissions and costs of life cycle of buildings, with a clever architectural design and energy efficiency the building energy consumption and related costs can be reduced. Energy efficiency with energy-efficient architecture as a way to optimize the architecture design with the aim to minimize energy consumption can be used for buildings with different uses and climates. These solutions can be developed as the criteria for urban planning and architectural design of buildings in different climates. Energy efficiency method with energy-efficient architecture in the administrative buildings in climatic condition is very important. The trends in designing new generation of administrative buildings as a pilot building provide efficient and economical energy. Applying the methods of energy efficiency solutions with energy-efficient architecture in designing the administrative building resulted in energy savings. The criteria of designing with standards of design which are dry and inflexible concepts are different. The criteria of designing are the solutions of designing that as a light can help the designer in order to create an ideal design to show desired features of designing.

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